



Hardware Design for Software Engineers

Presented by

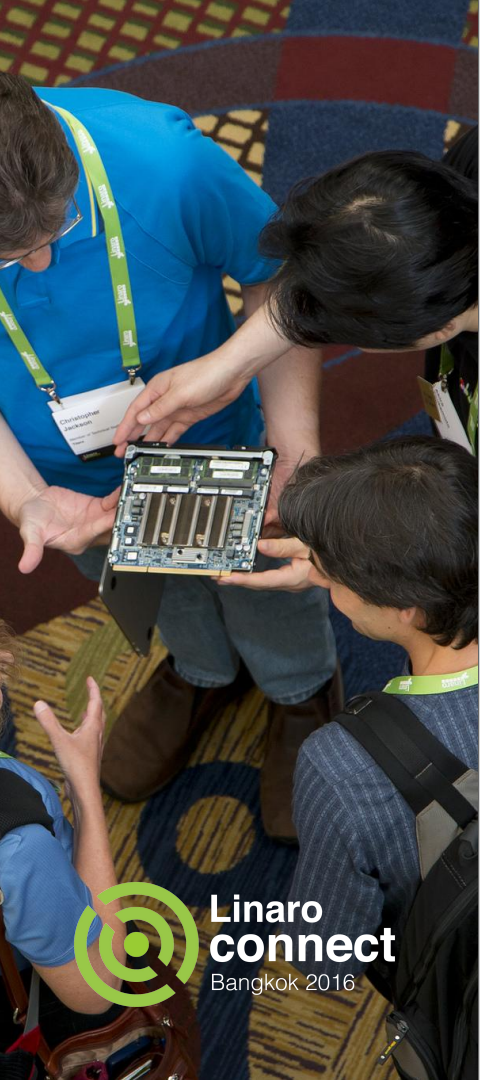
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Date

11 March 2016

Event

Embedded Linux Conference 2016
San Diego, California



“People who are really serious about software should make their own hardware”

Alan Kay, Creative Think Seminar, 1982

Why build your own hardware?

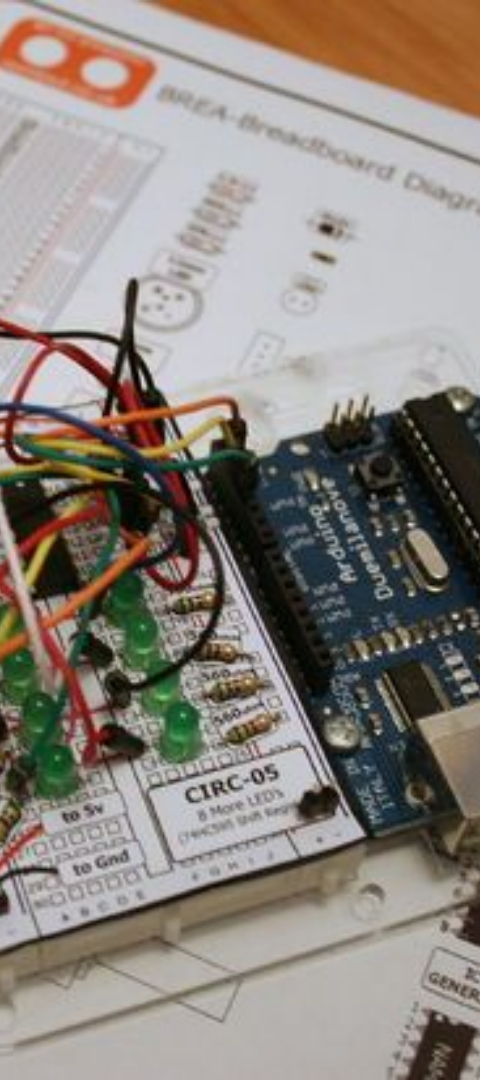
- Solve Software problems with Hardware
 - Test jigs
 - Real world interfaces
- Hardware design has never been easier
 - Free software tools
 - Prototype services
 - Manufacturing services
 - Sales channels



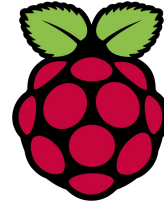
DISCLAIMER

I am *not* saying everyone should design hardware!

Adverse effects such as bricked boards, soldering iron burns, or slipped schedules are on your own head!



Start With The Basics



HACK A DAY

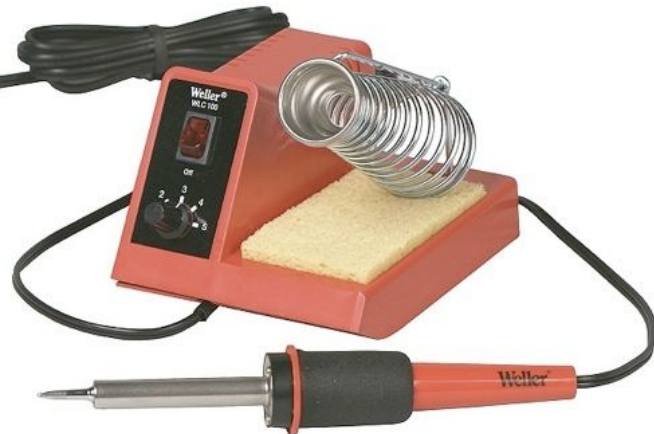


Be LICHEN*-PUB** Standards Compliant

*Linux Initiative for Cute Hacks of Embedded Nonsense**Peripheral Unifying Board

Equipment

- Soldering Iron
- Multimeter
- Helping hands



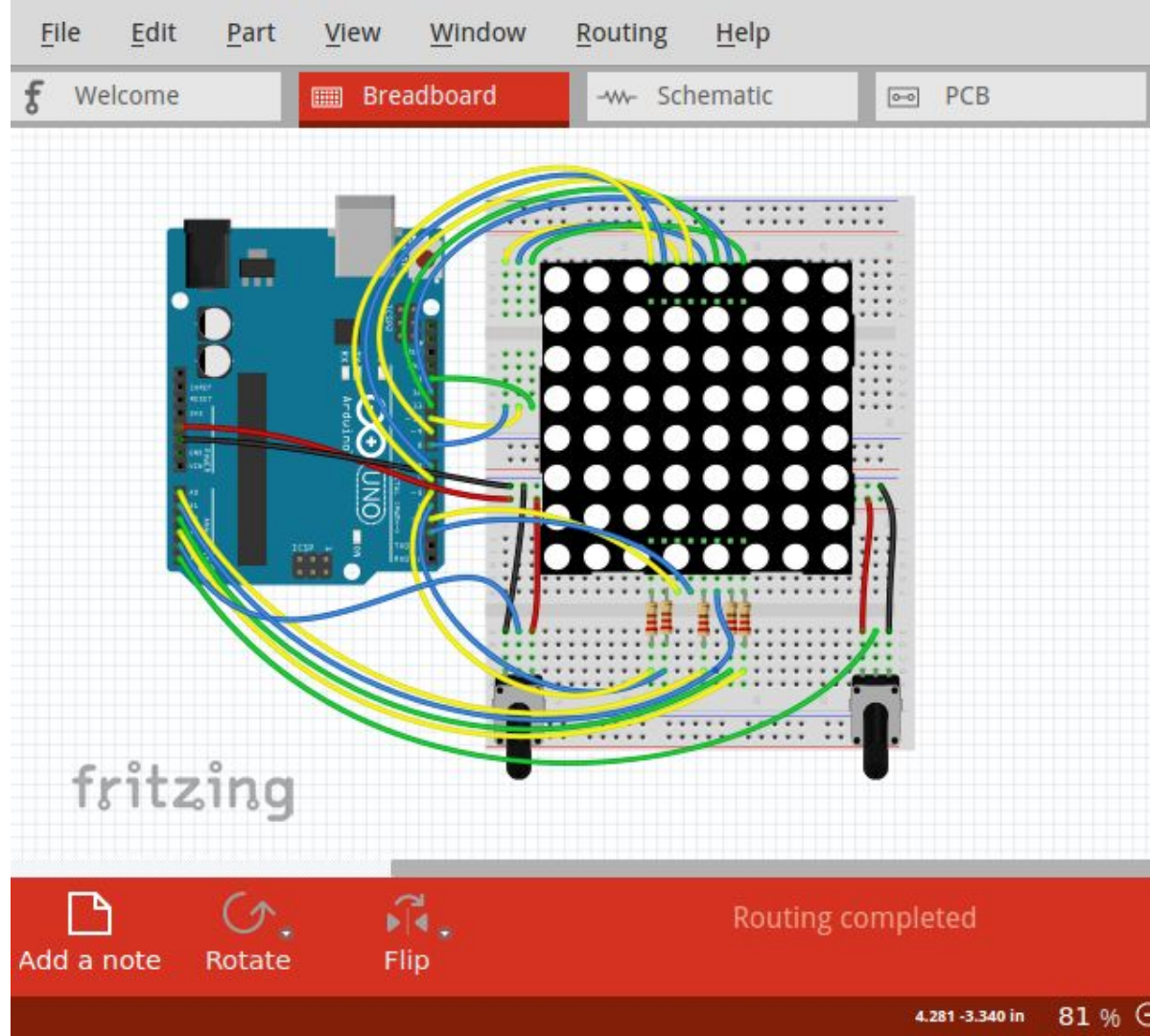
Support

- Local Hacker spaces
- Fab labs
- Online Forums

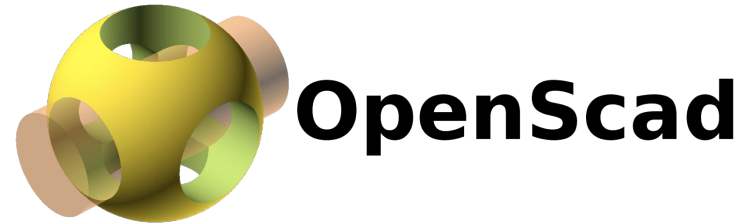
Design Tools

KiCad

fritzing



Design Tools



Prototyping

- PCB printing
 - DirtyPCBs
 - OSHPark
 - Seeed Fusion PCB
- Assembly
 - Do it yourself
 - Learn how to solder - lots of guides online
 - Prototype assembly services

Manufacturing

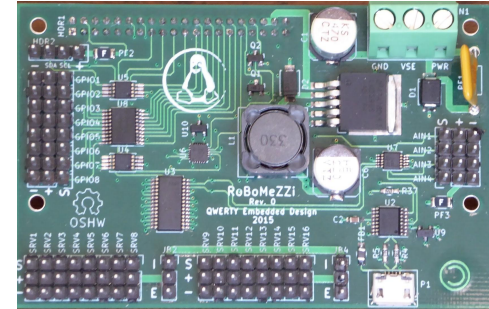
- Find a manufacturing partner
 - Doesn't have to be local
 - Should provide
 - Design for Manufacturing Review
 - Testing

Sales & Marketing

- Don't as me, I'm just an engineer

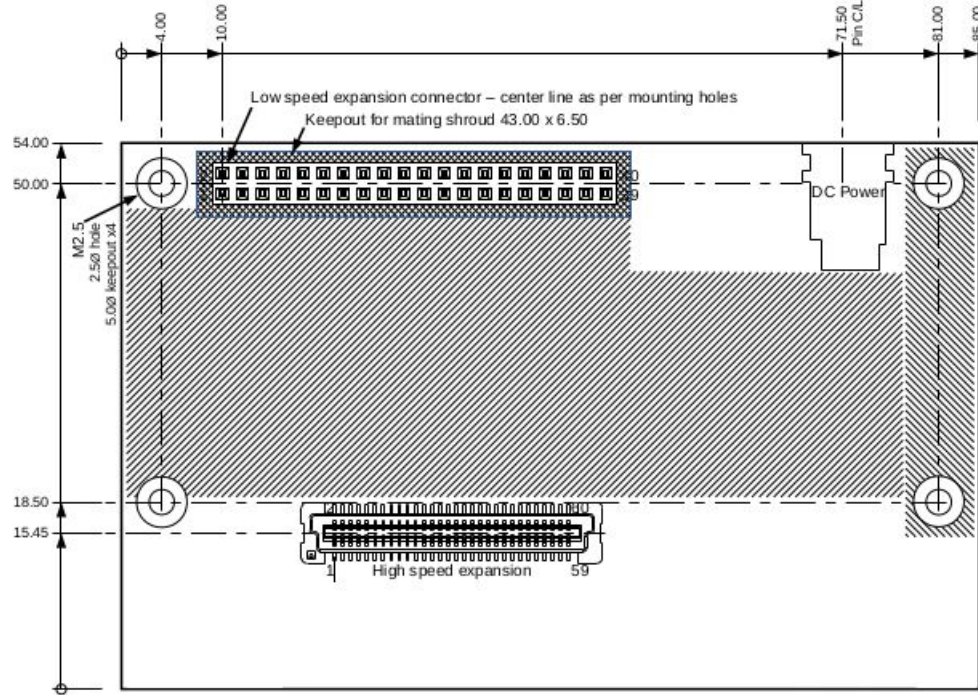
Example: Design for 96Boards

- Start with KiCad Template,
- or fork an existing design
 - 96Boards UART
 - Sensors Mezzanine
 - Robomezzi



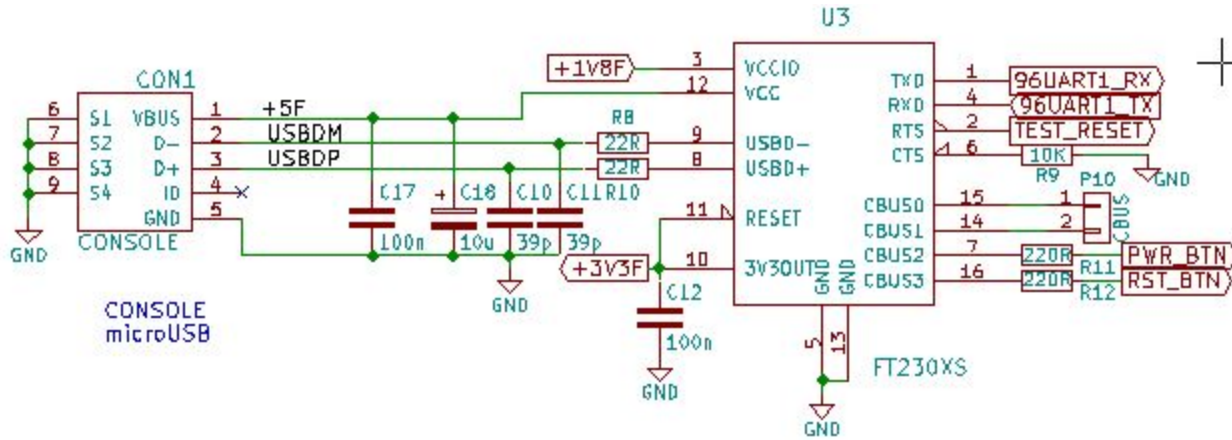
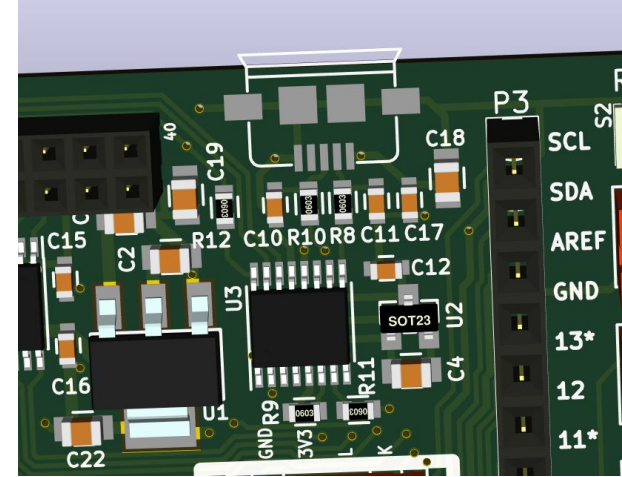
Mechanical

- 54x85mm
- 7mm minimum separation
 - LS connector only insufficient mechanically
 - Mount with standoffs
 - LS+HS mounts solidly
- Optionally stackable
 - Check height requirements
- Prefer surface mount
 - Through-holes may short



Choosing Components

- What footprints? (0603, SOT-23, etc)
- Use datasheets
- Look at Open Hardware designs
- Remember the passives
- Prototype on breadboard!



Power

- Supply
 - Often higher than IO voltage
 - Careful!
- Regulated Power
 - 5V/1A - Pin 37
 - 1.8V/0.1A - Pin 35
- 3.3V regulated down from 5V rail
- Use 1.8V (pin 35) as VIO reference

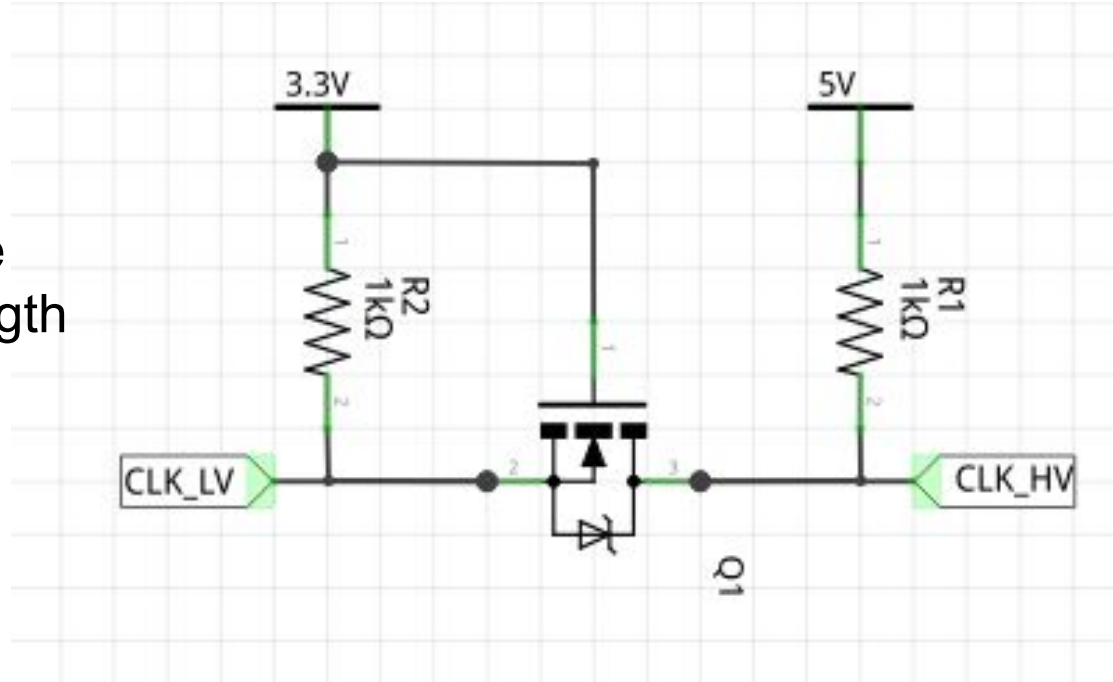
IO Voltage Level

Transparent level shifting is tricky. Options:

- One-way Buffers
 - When the signal is unidirectional
- Simple Clamp Style
 - BSS138 MOSFETs
 - PCA9306 dual channel (made for I²C)
- High Density Multi-Channel
 - Low drive strength
 - Good for short traces, poor for off-board
 - TXS010x - Clamp style
 - TXB010x - Push/pull

I²C

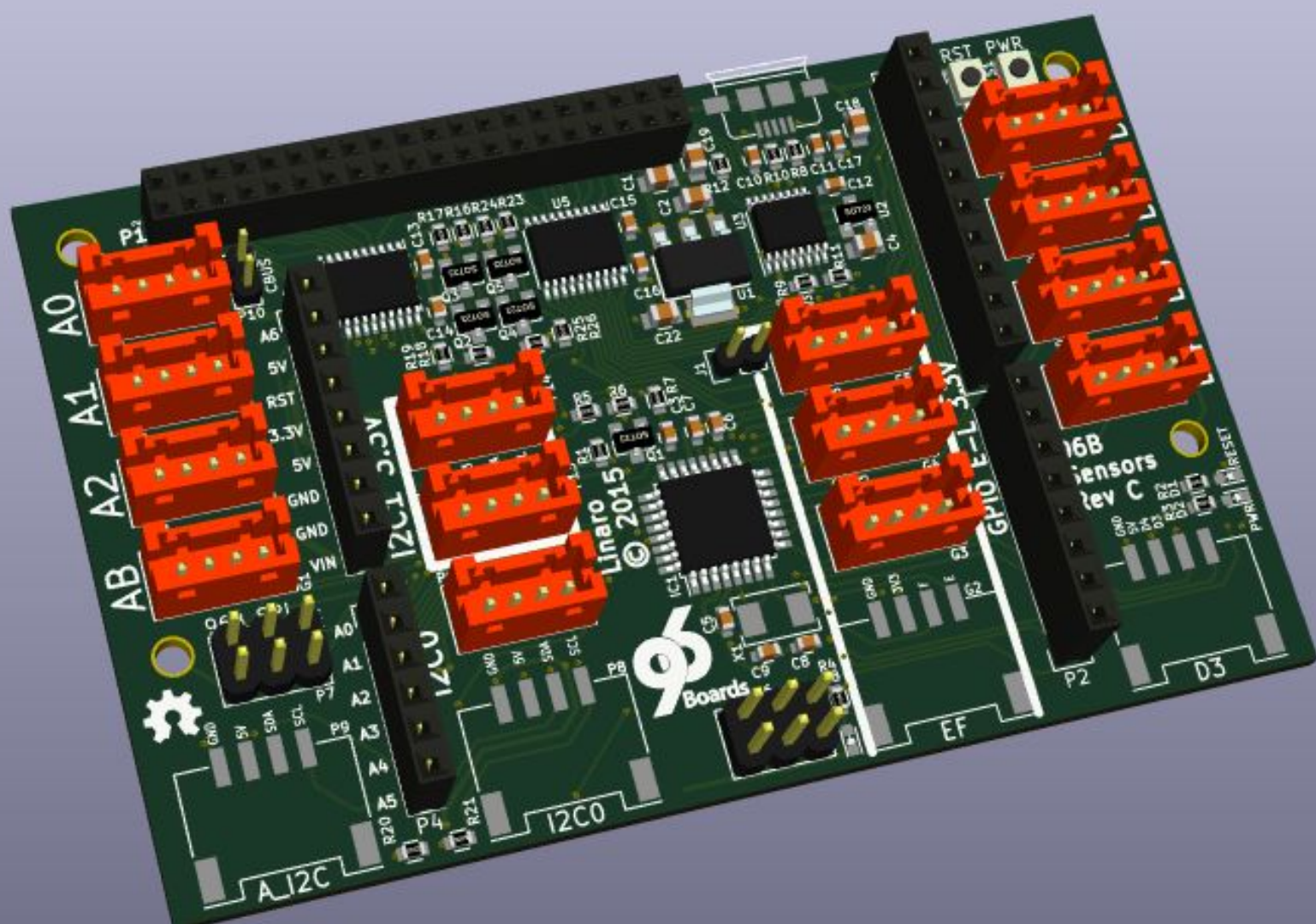
- Test before building
- BSS138 or PCA9306
- Not everything plays nice
- Check device drive strength
- Tailor pull-ups



Manufacturing

- Automate design package
 - Gerber files
 - BOM
 - Position file
 - Schematic
- Factory Test plan
- Documentation
- Prototyping vs. Production





Questions?